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TECHNICAL MEMORANDUM # M-1
ASBESTOS ANALYSIS OF WATER SAMPLES
BY
ELECTRON MICROSCOPY

JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS

JUNE, 1985

KUMAR MALHOTRA & ASSOCIATES, INC.
ENGINEERS • CONSULTANTS • PLANNERS
Grand Rapids, Michigan/Monroe, Wisconsin

KMA
• ENGINEERS • CONSULTANTS • PLANNERS •

KUMAR MALHOTRA & ASSOCIATES IN

3000 East Belt Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

June 6, 1985

Mr. Rodney Gaither
Project Coordinator
U.S. Environmental Protection Agency
Region V
230 S Dearborn Street
Chicago, Illinois 60604

Re: Johns-Manville Waukegan Disposal Area RI/FS

Dear Mr. Gaither:

Enclosed for your information is a copy of the report prepared for Johns-Manville summarizing the analysis of asbestos in the water samples by Electron Microscopy. The results will be incorporated as appropriate in the final RI report.

I hope this information will be of further assistance to you in your "Draft RI Report" review. I will be out of the country from June 22, 1985 to July 14, 1985 and will be looking forward upon my return to a meeting with you on your review comments.

Sincerely yours,

S. K. Malhotra, Ph.D., P.E.

cc: James H Whipple, P.E.
J.M.
SKM:sa

Technical Memorandum # M-1

ASBESTOS ANALYSIS OF WATER SAMPLES BY ELECTRON MICROSCOPY

Johns-Manville Disposal Area, Waukegan, Illinois

Two sets of ground water samples were collected in September, 1984 in accordance with the approved work plan for site hydrological and geotechnical investigations. One set was analyzed by Canton Laboratory, Ypsilanti, Michigan by phase-contrast microscopy. The results obtained are presented in Table 4-7 (p. 4-25) in the "Draft Remedial Investigation Report", Volume 1, March, 1985. These results indicated that the asbestos fiber concentration was below the detection limit of the analytical technique,which is less than 50,000 fibers/liter. Since it is quite common to find asbestos fibers in beverages and water in the order of several million fibers per liter (see Appendix M-1-B, "Report of the Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario" Volume II Chapter 11 - Asbestos in the Environment) it was decided to get the second set of samples analyzed for asbestos fibers by electron microscopy. As indicated in the Draft RI Report, these samples were sent to EMS Laboratories, Hawthorne, Calfornia. These were analyzed by using transmission electron microscopy technique "Interim method for determining asbestos in water", EPA-600/4-80-005. The results were obtained in the last week of March, 1985 and are presented in Appendix M-1-C. Asbestos fiber concentration of Well #3 sample was substantially less than that of Wells # 2 & 4 samples although it is located in between Wells # 2 & 4 and is in the general direction of ground water movement. These results also indicated that upgradient ground water (Well # 5) sample had higher asbestos fiber concentration than those of the downgradient ground water (Wells # 2, 3 & 4) samples. Because of these gross inconsistencies in the results a second round of ground water sampling was conducted on April 29 and April 30, 1985. Representatives of USEPA, were advised accordingly.

Each well was pumped for about 90 minutes at a rate of 13 to 18 gpm prior to sample collection. In addition, surface water samples from Lake Michigan were collected to provide comparative data with the ground water sampling data. The following surface water sampling locations were chosen for this purpose (See Figure M-1-1).

- O Lake Michigan shore, east of monitoring well #4
- O Lake Michigan shore, east of monitoring well # 2
- O Lake Michigan Shore, north of Commonwealth Edison cooling water discharge point
- O Lake Michigan, Waukegan City water intake

All water samples were shipped to EMS Laboratories, Hawthorne, California for asbestos fiber count by electron microscopy. The results are presented in Table M-1-1 and Appendix M-1-A.

FIGURE M-1-1
BORING AND MONITORING WELL/LAKE
SAMPLING LOCATION MAP

JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
S94-3224

Kumar Malhotra & Assoc., Inc. — Grand Rapids, Michigan

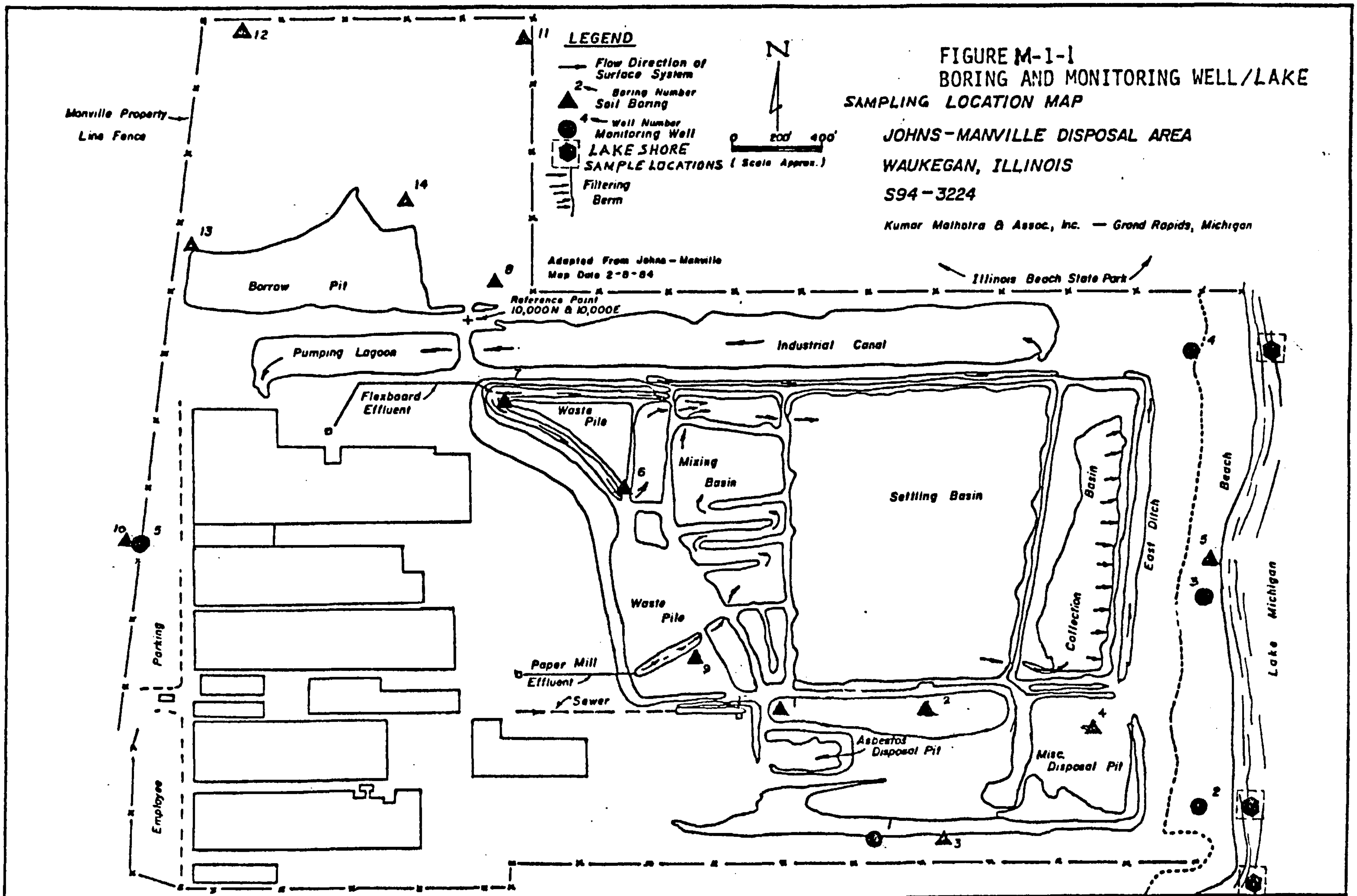

TABLE M-1-1

SUMMARY OF ASBESTOS RESULTS
(CHRYSOTILE FIBERS BY TEM)

Sampling Dates: April 29 and 30, 1985

Sample Description	Fibers Concentration
M.W #1	6
M.W #2	9
M.W #3	12
M.W #4	7.8
M.W #4 (Replicate)	10.8
M.W #5	7.5
Field Blank	0.2
Lake Michigan Shore (East of Well #4)	13
Lake Michigan Shore (East of Well #2)	11
Lake Michigan Shore, (North of Commonwealth Edison Cooling Water Discharge)	19
Lake Michigan, Waukegan City Water Intake	5.5

ASBESTOS ANALYSIS OF WATER SAMPLES BY ELECTRON MICROSCOPY

Johns-Manville Disposal Area, Waukegan, Illinois

Discussion of Results:

The second round of ground water sampling results show good consistency and are in the same range as the lake water sample results. The observed range of 6 to 12 million fibers/l in the ground water samples and 5.5 to 19 million fibers/l for the lake water samples are essentially the same, considering the inherent variability in the analytical procedure for counting asbestos fibers. Further, these observed asbestos levels in the lake and ground water samples are no different from those reported in the literature (Table 11.1 Appendix M-1-B - 11.7 million fibers/l in Italian Vermouth, 12.2 million fibers/l in Gingerale, and 9.5 million fibers/l in tap water in Hull, Quebec).

Based on the observed lake and ground water sampling results it is apparent that the Johns-Manville Waste Disposal Area at Waukegan, Illinois is not impacting the ground water and Lake Michigan water quality in the vicinity of the site.

APPENDIX M-1-A

ASBESTOS RESULTS OF GROUNDWATER AND
LAKE MICHIGAN WATER SAMPLES
COLLECTION IN APRIL, 1985
(Second Round of Sampling)

Client Kumar Molhotra + Assoc. Inc.

Sample Description Blank

EMS Lab No. 6242

Chrysotile Fibers	0.01	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	2×10^{-5}	µg/L
More/Less than 5 Chrysotile Fibers in Sample	Less	
Detection Limit	0.01	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	1	0	0	0	0	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	0	1	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	1	0	0	0	0	0

EMS Labor

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well #1 EMS Lab No. 6242

Chrysotile Fibers	6	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.05	µg/L
More/Less than 5 Chrysotile Fibers in Sample	Exactly Five	
Detection Limit	1.2	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	1	2	1	1	0	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	0	4	1	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	1	3	1	0	0	0

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well #2

EMS Lab No. 6242

Chrysotile Fibers	9	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.02	µg/L
More/Less than 5 Chrysotile Fibers in Sample	Less	
Detection Limit	3	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	2	1	0	0	0	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	1	2	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	2	0	0	1	0	0

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well # 3

EMS Lab No. 6942

Chrysotile Fibers	12	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.1	µg/L
More/Less than 5 Chrysotile Fibers in Sample	More	
Detection Limit	1.5	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	2	9	1	2	0	1

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	0	8	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	2	2	1	2	1	0

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well # 4

EMS Lab No. 6242

Chrysotile Fibers	7.8	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.05	µg/L
More/Less than 5 Chrysotile Fibers in Sample	More	
Detection Limit	0.6	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	4	5	1	1	1	1

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	2	11	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	4	3	4	1	0	1

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well # 4-A (REPLICATE WELL # 4) EMS Lab No. 6249

Chrysotile Fibers	10.8	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.08	µg/L
More/Less than 5 Chrysotile Fibers in Sample	More	
Detection Limit	0.6	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	3	8	3	2	2	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	1	15	2	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	6	7	2	1	2	0

Client Kumar Malhotra + Assoc. Inc.

Sample Description Well # 5

EMS Lab No. 6242

Chrysotile Fibers	7.5	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	0.02	µg/L
More/Less than 5 Chrysotile Fibers in Sample	Exactly Five	
Detection Limit	1.5	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	1	4	0	0	0	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	1	4	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	1	3	1	0	0	0

EMS Laboratories

Client KUMAR MALHOTRA + ASSOC., INC.

Sample Description EAST OF WELL #4 (LAKEMICH) EMS Lab No. 6242

Chrysotile Fibers	13	MFL
>5 Microns Length (Chrysotile)	1.2	MFL
Mass (Chrysotile)	0.1	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	1.2	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	1	8	1	0	0	1

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	2	5	4	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	4	4	0	2	0	1

EMS Laboratories

Client KUMAR MALHOTRA + ASSOC., INC.

Sample Description EAST OF WELL #2 (LAKE MICH) EMS Lab No. 6242

Chrysotile Fibers	11	MFL
>5 Microns Length (Chrysotile)	0.6	MFL
Mass (Chrysotile)	0.1	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	0.6	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	1	9	5	2	0	1

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	3	13	1	1	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	4	7	4	1	0	2

EMS Laboratories

Client KUMAR MALHOTRA + ASSOC., INC.

Sample Description NORTH OF COMMONWEALTH EDISON (LAKEMICH)

EMS Lab No. 6242

Chrysotile Fibers	19	MFL
>5 Microns Length (Chrysotile)	BELOW DETECTION LIMIT	MFL
Mass (Chrysotile)	0.2	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	1.2	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	2	7	4	2	1	0

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	1	13	2	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	2	8	3	2	1	0

EMS Laboratories

Client KUMAR MALHOTRA + ASSOC., INC.

Sample Description LAKE WATER INTAKE

EMS Lab No. 6242

Chrysotile Fibers	5.5	MFL
>5 Microns Length (Chrysotile)	0.2	MFL
Mass (Chrysotile)	0.04	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	0.2	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	6	9	4	0	1	3

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	0	21	2	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	7	8	4	0	2	2

Client Kumar Malhotra + Assoc. Inc

Sample Description Field Blank

EMS Lab No. 6242

Chrysotile Fibers	0.2	MFL
>5 Microns Length (Chrysotile)	Below Detection Limit	MFL
Mass (Chrysotile)	2×10^{-3}	µg/L
More/Less than 5 Chrysotile Fibers in Sample	More	
Detection Limit	0.03	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	2	1	4	0	0	1

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	0	8	0	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	3	1	3	0	0	1

APPENDIX M-1-B

CHAPTER 11

"ASBESTOS IN THE ENVIRONMENT"

From Volume II of Report of the Royal Commission on Matters of Health and Safety arising from the use of Asbestos in Ontario, Canada

B. Asbestos in Water, Food, Beverages, and Drugs

B.1 Introduction

In Chapter 5 we discuss the evidence regarding health effects of eating or drinking asbestos fibres. There we conclude that the evidence fails to indicate any increased risk of alimentary tract tumours following the direct ingestion of asbestos fibres. This conclusion is based on two sources of evidence. First, most animal evidence shows that feeding asbestos to animals does not cause an increase in gastrointestinal cancer, and in fact does not cause asbestos fibres to be lodged in the gastrointestinal tract. If the fibres are not retained in the gastrointestinal tract, as they are in the lungs, it is highly unlikely that they will cause disease. Second, epidemiological studies of human health related to asbestos levels in drinking water have generally found no health effects from high asbestos levels. In a Canadian study, Toft et al. analyzed water-borne asbestos levels and mortality rates in 71 municipalities across Canada.[25] The researchers concluded that there was not a significant relationship between water-borne asbestos levels and gastrointestinal cancer. A study by Conforti et al. was the only one of more than a half-dozen studies of health and asbestos in drinking water that suggested any such relationship, and even there the sug-

[25] P. Toft et al., "Asbestos and Drinking Water in Canada," *The Science of the Total Environment* 18 (1981): 77–89.

gested relationship was weak.[26] Only a fraction of the many analyses performed by Conforti et al. pointed to a correlation of asbestos with cancer, and the authors noted that confounding factors such as smoking, occupation, and alcohol consumption may be important but were not allowed for in the study.

In summary, we find that oral ingestion of asbestos in concentrations currently found in water, food, or beverages in North America is not associated with any significant increase in disease. Although negative epidemiological studies cannot conclusively prove that there is no association, the populations studied have been sufficiently large that all but the smallest health effects would have been detected. For their part, the bulk of the animal studies have shown no association between oral asbestos ingestion and gastrointestinal cancer.

We, therefore, find that there is no reason for public concern about the health effects of asbestos in water, food, and beverages. However, as the presence of asbestos in water, food, and beverages has been extensively studied, we summarize the data below.

B.2 Asbestos in Drinking Water

The measurement of asbestos fibre concentrations in water may be performed using transmission electron microscopy (TEM). The water sample is drawn through a Nuclepore filter, which is then carbon-coated. The filter is dissolved, leaving the thin carbon-coating with embedded fibres ready for examination using a TEM. The U.S. EPA has commissioned a study, to be published by early 1984, which develops a standardized method of measurement for asbestos fibres in water. The fibre concentration is usually reported in millions of fibres of all sizes per litre of water; there is usually no separate count of fibres longer than 5 microns. A comparison of these fibre concentrations with airborne fibre concentrations would be meaningless because serious disease may arise from exposure to airborne fibres, while there is no reason for concern about the health effects of asbestos in water.

Cunningham and Pontefract's Canadian study detected levels of asbestos in tap water, melted snow, and river water ranging from 2 million to 173 million fibres per litre.[27] These results are shown in Table 11.1. Unfiltered tap water in a Quebec asbestos mining town contained the highest

[26] Paul M. Conforti et al., "Asbestos in Drinking Water and Cancer in the San Francisco Bay Area: 1969–1974 Incidence," *Journal of Chronic Diseases* 34 (1981): 211–224.

[27] Hugh M. Cunningham and Roderic D. Pontefract, "Asbestos Fibres in Beverages and Drinking Water," *Nature (London)* 232 (30 July 1971): 332.

levels. River water contained more asbestos fibres than water drawn from a city filtration system and melted snow contained higher amounts than river water. Most fibres detected were below 1 micron in length.

Kay reported on asbestos fibre levels in drinking water from 21 cities in Ontario, drawing on surface waters for samples.[28] Samples were examined at a magnification which ranged from 25,000 to 50,000 times. As with Cunningham and Pontefract's investigation, the detected fibre levels varied widely. For instance, Kay found Ottawa's tap water to have a fibre count of 0.136 million fibres per litre, while Sarnia's count was 3.87 million fibres per litre. Kay's data are summarized in Table 11.2. Additional surveys undertaken in Metropolitan Toronto found levels of asbestos which ranged from 0.724 million to 4.06 million fibres per litre.

Health and Welfare Canada commissioned a national survey for asbestos fibres in Canadian drinking water in 1977.[29] The authors of the study, which was done under the auspices of the Ontario Research Foundation, relied on the U.S. EPA's preliminary interim method to evaluate the concentration and type of asbestos present in water samples. The study reported on samples from 71 locations across Canada, representing the water supplies of close to 55% of the Canadian population. Samples were obtained from the raw water source, from the water treatment plant, and from the water distribution network. The researchers concluded that amphibole asbestos was not a major contaminant of Canadian drinking water supplies. In locations where amphibole asbestos was detected, there was usually a much higher concentration of chrysotile fibres. The highest concentrations of chrysotile fibres were detected in Baie Verte, Newfoundland, and Disraeli, Quebec, at levels of up to 1,800 million fibres per litre. In Ontario, the highest levels were found in Thunder Bay, Kirkland Lake, and Hearst, with detected values of up to 3 million, 3.5 million, and 22 million fibres per litre respectively. Data from this study are shown in Table 11.3. Potable water in the 15 other locations sampled in Ontario had fibre levels below 1 million fibres per litre.

The difficulties in measuring asbestos fibre concentrations in water may be illustrated by the controversy surrounding asbestos levels in the water in Thunder Bay, Ontario, in 1975. Early in 1975, researchers at Lakehead University reported asbestos concentrations in the drinking water in that city ranging from 0.45 million fibres per litre to 14.7 million fibres

[28] G.H. Kay, "Asbestos in Drinking Water," *Journal American Water Works Association* 66:9 (September 1974): 513–514.

[29] Eric J. Chatfield and M. Jane Dillon, *A National Survey for Asbestos Fibres in Canadian Drinking Water Supplies*, 79-EHD-34 (Ottawa: Health and Welfare Canada, Environmental Health Directorate, 1979).

Table 11.1

Asbestos Fibre Concentrations in Beverages and Water

Sample	Source	Millions of Fibres per Litre
Beer	Canadian 1	4.3
Beer	Canadian 2	6.6
Beer	U.S.A. 1	2.0
Beer	U.S.A. 2	1.1
Sherry	Canadian	4.1
Sherry	Spanish	2.0
Sherry	South African	2.6
Port	Canadian	2.1
Vermouth	French	1.8
Vermouth	Italian	11.7
Soft drink	Ginger ale	12.2
Soft drink	Tonic water I	1.7
Soft drink	Tonic water II	1.7
Soft drink	Orange	2.5
Tap water	Ottawa, Ottawa River*	2.0
Tap water	Toronto, Lake Ontario*	4.4
Tap water	Montreal, St. Lawrence River*	2.4
Tap water	Hull, Quebec, Ottawa River**	9.5
Tap water	Beauport, Quebec, St. Lawrence River (6 km below Quebec City)**	8.1
Tap water	Drummondville, Eastern Townships, Quebec, St. François River*	2.9
Tap water	Asbestos, Eastern Townships, Quebec, Nicolet River*	5.9
Tap water	Thetford Mines, Eastern Townships, Quebec, Lac à la Truite**	172.7
Melted snow	Ottawa, top 30 cm (2-3 weeks' precipitation)	33.5
River water	Ottawa River, at Ottawa	9.5

Notes: *Filtration plant used.
**No filtration plant used.

SOURCE: Hugh M. Cunningham and Roderic D. Pontefract, "Asbestos Fibres in Beverages and Drinking Water," *Nature (London)* 232 (30 July 1971): 332.

Table 11.2

Asbestos Fibre Concentrations in Ontario Tap Water

Sample Location	Source	Millions of Fibres per Litre	Estimated Mass Concentration, Nanograms per Litre
Toronto	Lake Ontario	1.9	0.941
Belleville	Bay of Quinte	0.533	0.937
Brantford	Grand River	0.570	1.13
Brockville*	St. Lawrence River	0.446	0.602
Chatham	Thames River	0.595	1.57
Cornwall	St. Lawrence River	2.11	0.729
Hamilton	Lake Ontario	0.694	0.154
London	Lake Huron	0.456	0.429
Niagara Falls	Niagara River	2.58	2.25
North Bay*	Trout Lake	0.384	0.104
Oshawa	Lake Ontario	0.557	0.159
Ottawa	Ottawa River	0.136	0.093
Pembroke*	Ottawa River	2.85	0.538
Peterborough	Otonabee River	1.86	3.54
Port Colborne	Welland Ship Canal	0.608	0.847
Sarnia*	Lake Huron	3.87	2.13
Sault Ste. Marie*	St. Marys River	0.248	0.141
St. Catharines	Welland Ship Canal	1.03	1.56
Sudbury*	Ramsay Lake	0.297	0.542
St. Thomas	Lake Erie	1.60	0.500
Thunder Bay*	Lake Superior	0.830	0.235
Welland	Welland Ship Canal	0.820	0.479

Note: *No filtration plant used.

SOURCE: Adapted from: G.M. Kay, "Asbestos in Drinking Water," *Journal American Water Works Association* 66:9 (September 1974), Table 1, p. 514.

Table 11.3

Summary of Asbestos Fibre Concentrations in Ontario Tap Water (Millions of Fibres per Litre)

City	Chrysotile			Amphibole			Water Filtration
	Raw Water Input	Treated Water Output	Distribution Network	Raw Water Input	Treated Water Output	Distribution Network	
Cochrane	•	•	0 - 0.5	•	•	0 - 0.5	Yes
Hamilton	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	Yes
Hearst	•	•	11 - 22	•	•	0 - 1.5	No
Kenora	•	•	0 - 1	•	•	0 - 0.5	No
Kingston	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	Yes
Kirkland Lake	•	•	1 - 3.5	•	•	0 - 0.5	No
London	1	0 - 0.5	0 - 1	0 - 0.5	0 - 0.5	0 - 0.5	Yes
Matachewan	0 - 0.5	1	0 - 1	0 - 0.5	0 - 0.5	0 - 0.5	No
Matheson	7.5	1	0 - 1.5	0 - 1	0 - 0.5	0 - 0.5	No
North Bay	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	No
Ottawa	4.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	Yes
Peterborough	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.6	0 - 0.5	Yes
Sault Ste. Marie	•	•	0 - 0.5	•	•	0 - 0.5	No
Sudbury	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	No
Thunder Bay	2	1	2 - 3	0.5	0 - 0.5	0 - 0.5	No
Tilbury	14**	0 - 0.5	0 - 0.5	0 - 7	0 - 0.5	0 - 0.5	Yes
Toronto	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	Yes
Windsor	1.5	0 - 0.5	0 - 0.5	0 - 1.5	0 - 0.5	0 - 0.5	Yes

Notes: •Sample not analyzed.
**High solids content did not permit adequate sensitivity. Result reported corresponds to 2 fibres in 20 grid squares examined.

SOURCE: Adapted from: Eric J. Chatfield and M. Jane Dillon, *A National Survey for Asbestos Fibres in Canadian Drinking Water Supplies*, 79-EHD-34 (Ottawa: Health and Welfare Canada, Environmental Health Directorate, 1979), Table 6, p. 31.

per litre.[30] These data were reported in Thunder Bay and led to demands for investigation and for filtration of the city water supply. Independent tests conducted for the Ministry of the Environment showed fibre concentrations of less than 1 million per litre. At a Thunder Bay City Council meeting in April 1975 it was suggested that the high fibre counts produced by Lakehead University might have been the result of laboratory or analytical errors.

Attempting to resolve the controversy, the Ontario Ministry of the Environment established an inter-laboratory study, sending samples of Thunder Bay drinking water to five Ontario laboratories, including the Ontario Research Foundation, McMaster University, the Canada Centre for Inland Waters, Health and Welfare Canada, and Lakehead University. The last two laboratories did not participate in the study. The first three laboratories did analyze the water, yielding results which were described in a report dated September 1975. The average fibre count reported by the Canada Centre for Inland Waters was 0.63 million fibres per litre; McMaster University, 8.45 million; and the Ontario Research Foundation, 0.06 million fibres per litre.[31] Previous studies had shown the Thunder Bay water to contain less than 1 million fibres per litre.[32] The report suggested that the large inter-laboratory differences in reported fibre concentrations might be attributable to differences in counting techniques and differences in the criteria used to identify asbestos fibres. The Ontario Research Foundation, which used relatively sophisticated means for determining whether fibres were asbestos or some other mineral, reported the lowest fibre count. The report concluded by recommending that standards be set for measuring asbestos fibre concentrations in water. The Ontario Research Foundation has subsequently been engaged by the U.S. Environmental Protection Agency to develop a technique to be used for measuring the asbestos in water in the United States.

Asbestos may be deposited in water supplies by natural mechanisms such as the airborne transfer of fibres from wind erosion of asbestiform mineral outcroppings. Cunningham and Pontefract discussed surveys undertaken in British Columbia and the Yukon which linked the levels of asbestos in water to ground water drainage and surface run-off in areas where there was natural exposure of asbestos-bearing bedrock.[33]

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30 Don Smith, "University Dean of Science Urges Filtering of Water Now," *Chronicle-Journal* (Thunder Bay, Ontario), 18 April 1975, p. 1.

31 Ontario, Ministry of the Environment, "An Inter-laboratory Study of Asbestiform Mineral Fibre Levels in the Water Supply of Thunder Bay, Ontario," Rexdale, Ontario, September 1975, Table 7, p. 17.

32 Ibid., Table 9, p. 22.

33 Cunningham and Pontefract, "Asbestos Fibres in Beverages and Drinking Water," pp. 332–333.

Another possible source of fibre release into water supplies is the asbestos-cement pipe used for water distribution in sewage systems. Asbestos-cement pipes are composed of 85% Portland cement and 15% asbestos. The asbestos component contains both chrysotile and crocidolite fibres in approximately a 4 to 1 ratio.[34] Sometimes amosite is used in place of crocidolite. The amount of fibre release from interior wall deterioration of asbestos-cement pipe has been the subject of much investigation. Olson addressed this issue and concluded that ". . . water flowing through asbestos-cement pipe does not increase the level of fibre content significantly."[35] In contrast, Buelow, Millette, and McFarren have found that asbestos-cement pipe behaves much like other piping materials, except plastic, that are in common use for the distribution of drinking water. If aggressive conditions towards the piping material exist (measured by pH, alkalinity, and hardness), the pipe will corrode and deteriorate.[36]

Mah and Boatman utilized transmission and scanning electron microscopy to study the interaction between water and asbestos-cement pipe. After one month of water flow, bundles of asbestos fibres were observed on the inner surface of pipe which had originally been smooth. Additionally, aggressive water circulated for 218 days in asbestos-cement pipes exhibited ~~an asbestos content of 3.6 million fibres~~ per litre. Prior to the 218-day ~~period, the asbestos content was 1.35 million fibres~~ per litre.[37]

Substitutes with equivalent performance characteristics are available for asbestos-cement pipe for sewage and water distribution applications. However, for pipe diameters of 24 inches and less, the use of substitutes may not be cost competitive.[38]

It appears that the most important source of asbestos deposition in large cities is industrial. High concentrations of asbestos fibres in water supplies near asbestos mining and manufacturing sites may result from the disposal of industrial asbestos-containing waste. The most notable example

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[34] Data from Johns-Manville Canada. See also, Robert A. Clifton, "Asbestos," in *Mineral Facts and Problems*, 1980 ed. (Washington, D.C.: U.S. Department of the Interior, Bureau of Mines, 1981), pp. 1-17.

[35] Harold L. Olson, "Asbestos in Potable-Water Supplies," *Journal American Water Works Association* 66:9 (September 1974): 515-518.

[36] R.W. Buelow, J.R. Millette, and E.F. McFarren, "Field Investigation of the Performance of Asbestos-Cement Pipe Under Various Water Quality Conditions," Cincinnati, Ohio, U.S. Environmental Protection Agency, 1977.

[37] M. Mah and E.S. Boatman, "Scanning and Transmission Electron Microscopy of New and Used Asbestos-Cement Pipe Utilized in the Distribution of Water Supplies," in *Scanning Electron Microscopy* 1978/I, ed. O. Johari (AMF O'Hare, Illinois: SEM Inc., 1978), pp. 85-92.

[38] Richard A. Simonds and James L. Warden, "Substitutes for Asbestos-Cement Pipe," in *Proceedings of the National Workshop on Substitutes for Asbestos*, Arlington, Virginia: 14-16 July 1980, EPA-560/3-80-001 (Washington, D.C.: U.S. Environmental Protection Agency, 1980), p. 160.

arises from the Reserve Mining Company, mining a low grade taconite ore in Babbitt, Minnesota, which is sent to Silver Bay for refining. For every ton of pellets produced, more than 2 tons of silica waste tailings containing cummingtonite are discharged into Lake Superior. Until legal action halted the dumping of the tailings into the lake, the company disposed of 67,000 tons of waste per day. This allegedly caused the concentration of amphibole fibres in Duluth drinking water to rise to between 1 million and 644 million fibres per litre.[39] As well, it was asserted in studies presented during litigation that effluent asbestos particles could move several hundred miles.[40]

We are not aware of asbestos wastes in Ontario being discharged into fresh water lakes in quantities approaching those discharged by Reserve Mining. In any event, we have concluded that the evidence fails to indicate adverse health effects from asbestos fibres in water.

In the United States, the Asbestos Manufacturing Point Source Category Regulations,[41] promulgated under the authority of the *Federal Water Pollution Control Amendment Act* of 1972,[42] limit pollution discharge, including total suspended solids, pH, and chemical oxygen demand, for effluents from various asbestos sources. The Act requires that all industrial sources treat effluents by applying the *best practicable control technology* (BPT) available by July 1, 1977 and the *best available control technology economically achievable* (BAT) by July 1, 1984. The BPT and the BAT are both defined for various asbestos manufacturing concerns. It is not anticipated that these targets will be achieved.

While the U.S. Food and Drug Administration has statutory authority to protect the public from unsafe hazards, no regulations governing levels of asbestos in water have been passed.

In the United Kingdom, the *Water Act, 1973*, requires local authorities to supply "wholesome" water.[43] The Model Water Byelaws, 1966, promulgated under this Act, prohibit allowing materials which can cause contamination to come into contact with water.

In Canada, the federal government has not established standards regulating asbestos-containing effluents. Most provinces have enacted water quality legislation. In most cases, these statutes contain general prohibitions preventing the deposit of substances in water which degrade water quality.

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[39] R.W. Durham and Thomas W.S. Pang, *Asbestos Fibers in Lake Superior*, American Society for Testing and Materials: Special Technical Publications, no. 573 (Philadelphia: ASTM, 1975).

[40] *U.S. v. Reserve Mining*, 380 F. Supp. 11; 6 ERC 1657 at 1669 (1974).

[41] 39 FR 7526, 26 February 1974.

[42] 33 U.S.C.A. § 1251.

[43] 21 Eliz. II, c. 37, s. 11(2).

Effluent discharge into water is, in Ontario, subject to the provisions of the *Ontario Water Resources Act*, which prohibits the deposit of any material which may cause injury to any person, animal, bird, or any living thing.[44] However, regulations promulgated under the Act do not set specific effluent standards for asbestos. The "Ontario Drinking Water Objectives," developed by the Ministry of the Environment, state that it is not possible at present to establish a standard for asbestos levels in drinking water, in view of the lack of epidemiological data.[45]

In view of our conclusions set out at the beginning of this section that the evidence fails to indicate adverse health effects from oral ingestion of asbestos, we do not recommend any change in the Ministry of the Environment's present approach to asbestos in drinking water. The health evidence does not suggest a need for standards for asbestos levels in water at this time.

B.3 Food and Beverages

Asbestos has been widely used as a component of filters employed by the food industry. Cunningham and Pontefract measured the amount of asbestos in filtrate using electron microscope methods and found these levels to be comparable to those in tap water, melted snow, and river water.[46] For the Canadian samples, all the asbestos identified was chrysotile, with a length less than 1 micron. The study found between 1.1 million and 6.6 million asbestos fibres per litre in Canadian and American beer and between 1.7 million and 12.2 million fibres per litre in Canadian soft drinks.

Wehman and Plantholt detected asbestos in commercial gin.[47] Gaudichet et al. studied asbestos fibres in 42 bottles of wine from France and abroad and found statistically significant concentrations of chrysotile asbestos in 15 bottles. Concentrations ranged from 2 million to 60 million fibres per litre with a fibre length of from 0.9 to 3.9 microns.[48]

In June 1977, the Consumers' Association of Canada (CAC) published findings similar to those cited above. According to tests conducted by the CAC, levels of asbestos in excess of 2 million fibres per litre could be

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[44] R.S.O. 1980, c. 361, ss. 14, 15(3), 16(1), and 16(3).

[45] Ontario, Ministry of the Environment, Water Resources Branch, "Ontario Drinking Water Objectives," Toronto, in press, 1983.

[46] Cunningham and Pontefract, "Asbestos Fibres in Beverages and Drinking Water," p. 332.

[47] Henry J. Wehman and Barbara A. Plantholt, "Asbestos Fibrils in Beverages. I. Gin," *Bulletin of Environmental Contamination and Toxicology* 11:3 (March 1974): 267-272.

[48] A. Gaudichet et al., "Asbestos Fibers in Wines: Relation to Filtration Process," *Journal of Toxicology and Environmental Health* 4:5-6 (September-November 1978): 853-860.

detected in foreign wines. The CAC asserted that "The presence of any asbestos in wine is unnecessary and dangerous" and recommended ". . . prohibition of the use of asbestos filters in preparation of any material which would find its way into the human body. . . ."[49]

However, the CAC study and the other beverage surveys cited above did not show that asbestos filters were responsible for the asbestos contamination in beverages and water. In order to identify the filter as a source of fibre emission, it would have been necessary to demonstrate that the asbestos levels found in water used for beverage production were significantly lower than the levels detected in the final product. However, none of the studies above presented such measurements. The Health Protection Branch of Health and Welfare Canada does not consider action restricting the use of asbestos as a filter component to be necessary on the basis that ". . . it does not appear that the use of asbestos component filters results in levels of asbestos fibres in the finished product above natural background levels."[50] We agree with this conclusion.

We note, however, that in Ontario, the Liquor Control Board (LCBO) reacted to the publication of the CAC report by issuing a directive calling for the immediate cessation of the use of asbestos filters by domestic and foreign producers of wines, spirits, and beer.[51]

In its submission to this Commission, A.O. Wilson Process Equipment Limited, a filter manufacturer, charged that the LCBO has enforced the directive in a fashion which imposes severe restrictions on Ontario wine producers while turning a blind eye to violations committed overseas:

> Wine filtration in each and every major wine producing country of the world is, to our knowledge, using the finest filtration material available — "asbestos," and their respective products are being imported into the province of Ontario and sold through our LCBO to the public. But it's a *no no* for Ontario wineries to use this identical material to filter their wines.[52]

Our staff has determined that only a few samples are examined by the LCBO each year, out of millions of bottles sold and hundreds of brands listed. Although foreign manufacturers are informed of the directive, it is

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[49] "Test: Asbestos in Wine," *Canadian Consumer* (June 1977): 44–47.

[50] Sandra Glasbeek, *A Survey of Asbestos Policies in Canada with Particular Emphasis on Ontario*, Royal Commission on Asbestos Background Paper Series, no. 1 (Toronto: Royal Commission on Asbestos, 1981), p. 40.

[51] Ibid.

[52] A.O. Wilson Process Equipment Limited, Written submission to the Royal Commission on Asbestos, #58, 1981, p. 2.

reasonable to assume that without greater diligence in monitoring and enforcement, these overseas manufacturers will enjoy a wide degree of latitude in complying. It therefore appears that the use of asbestos filters by foreign producers continues unimpeded.

Regarding the adequacy of substitute materials, it appears that the filters containing non-asbestos substitutes, such as cellulose and glass, are equal in performance to asbestos filters, save for the removal of "haze" from liquid beverages, an important limitation. These non-asbestos filters, which can be used interchangeably with asbestos filters, are reported to cost 10 to 15% more than asbestos filters.[53]

Other jurisdictions have not imposed comprehensive regulations on asbestos in food and beverages. In the United States, consideration was given to regulating the use of asbestos in talc used as a food or ingestable drug ingredient, but action was deferred until further evidence on the effect of asbestos ingestion was available.

In the United Kingdom, the *Food and Drugs Act, 1955*, provides that no substance may be added to food that would render it "injurious to health."[54] However, with one minor exception, no regulations have been enacted which specifically address the question of asbestos in food. The one exception is in the Miscellaneous Additives in Food Regulation, 1980, which provides that asbestos should not be present in food talc.[55] The U.K. Advisory Committee on Asbestos rejected specific statutory control of asbestos in food, but recommended a review of information concerning the risk to health from the contamination of food and drink by asbestos. The Advisory Committee also reported the recommendation of a Food Additives and Contaminants Committee that attempts should be made to find alternative materials for asbestos filters used in the preparation of food.[56] Apparently, the great majority, if not all, uses of asbestos filters in the preparation of food and drink have now been phased out in the United Kingdom. This was accomplished by industry, with the encouragement of government.[57]

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[53] GCA Corporation, "Asbestos Substitute Performance Analysis," draft revised final report prepared by Nancy Krusell and David Cogley for the U.S. Environmental Protection Agency, GCA-TR-81-32-G (Bedford, Mass.: GCA Corporation, February 1982), pp. 52-63.

[54] 4 Eliz. II, c. 16, s. 1(1).

[55] S.I. 1980/1834.

[56] U.K., Advisory Committee on Asbestos, *Asbestos — Volume I: Final Report of the Advisory Committee* (Simpson Report), William J. Simpson, Chairman (London: Her Majesty's Stationery Office, 1979), paragraphs 260-263 and Recommendation 39, pp. 92-93; and paragraphs P23-P24, p. 95.

[57] Telephone communication between Mr. Stanley King and Royal Commission on Asbestos Staff, 29 June 1983.

At the federal level in Canada, the *Food and Drug Act* provides that no person shall sell an article of food that has in it a "poisonous or harmful" substance.[58] No regulations have been passed under this Act which would restrict the use of asbestos in the food industry.[59]

In most provinces, provincial public health legislation contains provisions for control over food. Food unfit for human consumption may be prohibited under such legislation. The Ontario *Public Health Act* provides that local authorities may regulate the maintenance of premises where food or beverages are being produced.[60] The Food Premises Regulation under the *Public Health Act* provides that premises where food is handled must be free from any condition that may be "dangerous to health."[61] However, the only Ontario agency to prohibit the use of asbestos in food and beverage preparation is the Liquor Control Board, which, as discussed above, has prohibited the use of asbestos filters by producers of wines, spirits, and beer.

In view of the evidence summarized above on the health effects of ingested asbestos, and in view of the fact that asbestos fibre levels in filtrate do not appear to be significantly higher than levels in drinking water, we see no need for new legislation which would specifically limit levels of asbestos in food and beverages. In the same vein, because there is no evidence that asbestos filtration of wines, spirits, and beer causes health problems or that asbestos filters raise the asbestos concentration in beverages, and because the LCBO ban on asbestos filters is not and cannot be enforced effectively against foreign producers, we recommend that:

11.4 The Ministry of Consumer and Commercial Relations should take steps to repeal the Liquor Control Board of Ontario ban on the use of asbestos filters.

B.4 Drugs

Drugs which are injected directly into the body should be considered as posing potentially different concerns than do materials which are inhaled or ingested. Nicholson, Maggiore, and Selikoff examined samples of parenteral (i.e., injectable) drugs in order to determine if they contained asbestos fibre concentrations greater than those in distilled water used in reconstitution. One-third of the samples from two sets of 17 widely used parenteral drugs were found to have levels of chrysotile in excess of those found in

[58] R.S.C. 1970, c. F-27, s. 4(a).
[59] Food and Drug Regulations, CRC, Vol. VIII, c. 870, p. 5963.
[60] R.S.O. 1980, c. 409, s. 9, pars. 20, 21, 38, 39.
[61] R.R.O. 1980, Reg. 840, s. 12(a)(i).

distilled water. The researchers linked the chrysotile contamination to the use of chrysotile-containing filters in the manufacture of drugs.[62]

Selikoff and Lee have reported on a follow-up study undertaken in 1974 to determine whether contamination was a continuing problem with injectable drugs and whether it occurred in oral drugs. Of the 49 parenteral drugs sampled, 8 were found to have concentrations of asbestos at least 10 times greater than the average background levels in terms of both number and mass of fibres present. None of the oral drugs showed significantly high concentrations of asbestos.[63]

In the United States, a study was undertaken on the carcinogenic effects of intravenous injection of small fibres of chrysotile asbestos into rats and mice. The Research Project Summary concluded as follows:

> The studies have demonstrated that by the intravenous route the administration of fairly large doses of chrysotile asbestos to standard strains of mice and rats on an acute and subacute basis can be tolerated, and have little effect on survival rate. At large doses, up to about 1.6×10^{10} fibers/kg, over a period of 4 weeks, no carcinogenic effects were demonstrated in rats when studied for a lifetime. On the other hand, whereas mice survived well, there was evidence of carcinogenicity that was dose related and time related and possibly sex related. Whereas there were not enough animals on test to demonstrate a "no effect" dose, there is a suggestion that this dose would be fairly high, perhaps as high as 8×10^{8} fibers/kg. Of course there is no way of extrapolating such figures from mouse to man, and man frequently has a body burden (lung) from the inhalation route. It would seem prudent to avoid exposure to chrysotile asbestos in parenteral products whenever possible, and this has been done in the FR Final Order dated March 14, 1975.[64]

Comparing the huge doses administered in the U.S. study to the trace asbestos found in filtered drugs leads us to conclude that the risk of cancer caused by the injection of drugs is negligible.

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[62] William J. Nicholson, Carl J. Maggiore, and Irving J. Selikoff, "Asbestos Contamination of Parenteral Drugs," *Science* 177:44 (14 July 1972): 171–173.

[63] Irving J. Selikoff and Douglas H.K. Lee, *Asbestos and Disease* (New York: Academic Press, 1978), pp. 128–130.

[64] U.S., Food and Drug Administration, National Center for Drugs and Biologics, Research Project Summary of FDA 223-77-3017, and prior contracts entitled "Animal Studies of Chrysotile Asbestos by the I.V. Route," prepared by International Research and Development Corporation, Mattawan, Michigan, 18 December 1980, p. 119. See also, 40 FR 11865-11869, 14 March 1975.

The U.S. Final Order of March 14, 1975, referred to above, prohibits the use of asbestos filters in the manufacture, processing, or packaging of parenteral drugs, unless it is not possible to manufacture that drug without the use of such a filter.[65] If use of an asbestos filter is necessary, an additional non-fibre releasing filter must be used unless it is proved that such additional filtration would compromise the safety or effectiveness of the drug.

In Canada, drugs are regulated by the federal government under the *Food and Drug Act*.[66] There is no regulation regarding the presence of asbestos in drugs or the use of asbestos in the manufacture of drugs.

The provinces may regulate asbestos contamination in drugs by virtue of their capacity under the Constitution to protect public health. In some provinces, specific provision is made for regulation of the quality of drugs, either through public health legislation or through legislation governing pharmaceuticals. In Ontario, the *Public Health Act* allows the Ministry of Health to control the sale of impure vaccines and serums.[67] We are not aware of any provincial law directed specifically at asbestos in drugs.

The Health Protection Branch of Health and Welfare Canada has informed the Commission that it is aware of only two applications in which asbestos may be present in the manufacture of drugs in Canada. The Salk vaccine, administered subcutaneously, is filtered with an asbestos filter and is subsequently filtered two more times, first with a nylon filter and then with a Millipore filter. The Sabin vaccine, given orally, is filtered with an asbestos filter and then with a nylon filter. The secondary non-asbestos filters serve to reduce the asbestos content in the drugs. Manufacturers of these drugs are currently attempting safely to eliminate the use of asbestos filters; this may be a few years away.[68]

We see no need for regulatory action to reduce the existing use of asbestos filters in parenteral drugs in Canada.

[65] 21 CFR Part 133.
[66] R.S.C. 1970, c. F-27.
[67] R.S.O. 1980, c. 409, s. 7(c).
[68] Telephone communication between Dr. John Furesz, Director, Bureau of Biologic Drugs-Health Protection Branch, Health and Welfare Canada and Royal Commission on Asbestos Staff, 16 May 1983.

APPENDIX M-1-C

ASBESTOS RESULTS OF GROUNDWATER SAMPLES
COLLECTED IN SEPTEMBER, 1984
(First Round of Sampling)

Client CANTON ANALYTICAL LABORATORIES

Sample Description BLANK

EMS Lab No. 6066

Chrysotile Fibers	0	MFL
>5 Microns Length (Chrysotile)	0	MFL
Mass (Chrysotile)	0	μg/L
More/Less than 5 Chrysotile Fibers in Sample	LESS	
Detection Limit	0.02	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles						

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles						

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles						

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-939 Well #1

EMS Lab No. 6066

Chrysotile Fibers	1.5×10^4	MFL
>5 Microns Length (Chrysotile)	6.4×10^2	MFL
Mass (Chrysotile)	2.0×10^2	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	1.3×10^2	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	12	36	30	12	8	15

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	2	93	17	1	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	22	38	22	7	7	17

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-940 Well #2 EMS Lab No. 6066

Chrysotile Fibers	1.5×10^3	MFL
>5 Microns Length (Chrysotile)	72	MFL
Mass (Chrysotile)	25	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	9.0	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	29	63	36	11	5	19

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	16	129	15	2	0	1

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	37	64	29	10	8	15

EMS Laboratories

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-941- Well #3 EMS Lab No. 6066

Chrysotile Fibers	1.7×10^2	MFL
>5 Microns Length (Chrysotile)	2.7	MFL
Mass (Chrysotile)	1.9	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	1.4	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	28	49	21	8	4	15

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	11	109	9	3	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	34	42	23	8	4	14

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-942 Well #3 (REPLICATE) EMS Lab No. 6066

Chrysotile Fibers	1.5×10^2	MFL
>5 Microns Length (Chrysotile)	12	MFL
Mass (Chrysotile)	3.8	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	1.4	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	8	37	17	19	7	23

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	9	85	12	2	3	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	16	29	23	18	5	20

EMS Laboratories

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-943 Well #4 EMS Lab No. 6066

Chrysotile Fibers	5.0×10^3	MFL
>5 Microns Length (Chrysotile)	2.5×10^2	MFL
Mass (Chrysotile)	76	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	49	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	9	41	22	4	4	22

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	10	82	7	3	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	14	46	16	5	7	20

Client CANTON ANALYTICAL LABORATORIES

Sample Description 9-944 Well #5 EMS Lab No. 6066

Chrysotile Fibers	3.4×10^3	MFL
>5 Microns Length (Chrysotile)	2.3×10^2	MFL
Mass (Chrysotile)	1.0×10^2	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	29	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	8	29	26	15	11	29

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	9	92	14	2	1	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	17	30	26	12	11	22

MS Laboratories

lient CANTON ANALYTICAL LABORATORIES

ample Description 9-945 Field Blank EMS Lab No. 6066

Chrysotile Fibers	0.8	MFL
>5 Microns Length (Chrysotile)	BELOW DETECTION LIMIT	MFL
Mass (Chrysotile)	0.01	µg/L
More/Less than 5 Chrysotile Fibers in Sample	MORE	
Detection Limit	0.02	MFL

SIZE DISTRIBUTION
(Chrysotile Only)

Particle Length - Microns

	0-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.5 up
No. of Particles	7	15	13	7	1	6

Particle Width - Microns

	0-0.04	0.05-0.09	0.10-0.14	0.15-0.19	0.20-0.24	0.25 up
No. of Particles	5	37	7	0	0	0

Aspect Ratio L/W

	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50 up
No. of Particles	7	22	10	5	1	4